	Experiment title:	Experiment number:
	Details of complex magnetic interactions in the magnetic phase diagram of $NpAs_{1-x}Se_x$	HE-1624
Beamline: BM28	**Date of experiment:** from: 25/02/04 to: 2/03/04	**Date of report:** 9/03/2004
Shifts: 18	**Local contact(s):** Danny Mannix	*Received at ESRF:*

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Report:

This was the first transuranium experiment that took place on BM28 (XMaS) and it was most successful. We have examined two samples of composition $NpAs_{0.90}Se_{0.10}$ and $NpAs_{0.95}Se_{0.05}$ (1.40 and 1.98 mg), with the aim of investigating the complex magnetic interactions in these solid solutions using RXMS.

The data collected in this experiment was of high quality as shown in Figs. 1-4. At the Np M_{IV} edge the counting rate at the main antiferromagnetic reflections was ~5000 counts/s. Two open questions remained from a previous neutron scattering experiment [1], namely the single-k or multi-k nature of the incommensurate magnetic phase and the true symmetry of the mixed phase at low temperature where a coexistence of ferromagnetic and antiferromagnetic components was observed. It was not clear whether the two components came from the same grain or from different grains with slightly different stoichiometry. Our data unambiguously determined that the incommensurate phase that precludes the onset of ferromagnetism is single-k and that the mixed phase at low-T is intrinsically ferrimagnetic. A high resolution measurement of magnetostriction at high energy using a Si(444) analyzer (fig 3) clearly shows an orthorhombic lattice distortion taking place at T_C= 128 K, which agrees with the most likely model suggested from the neutron data.

A most exciting finding in this experiment was the observation of resonant ferromagnetic scattering at the Np M_{IV} edge, with a large scattering enhancement sitting on top of the charge peaks and disappearing at the ordering temperature of the ferromagnetic moments (fig 1 and 2). This scattering was observed on the $\sigma \rightarrow \pi$ channel with a Au(111) analyzer at 90º that filtered most of the charge leakage. To our knowledge, such effect was not previously reported and extends the field of RXMS to the investigation of ferromagnetic/ferrimagnetic samples in the actinides where the resonance is large.

We have also searched for a resonant signal at the K-edges of the p-elements, that were previously observed in the isostructural $UAs_{1-x}Se_x$ system [3] and were assigned to a small transferred magnetic moment due to

hybridisation between the 5f electrons and the conduction band. We have found such resonant signal at the As K-edge, on the rotated polarization channel, at the main antiferromagnetic reflections. The temperature dependence of the scattered intensity at the As K-edge follows closely that measured at the Np M_{IV} edge and the widths of the two resonances are comparable.

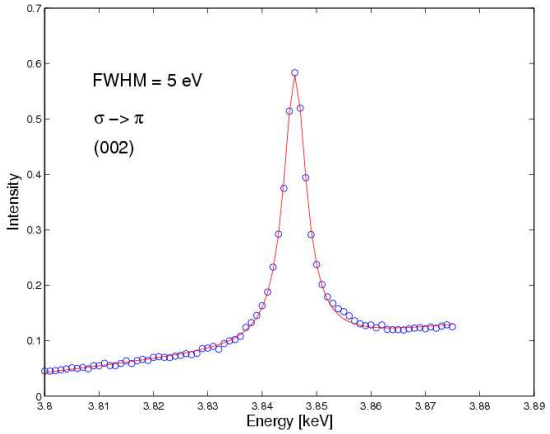

Fig 1

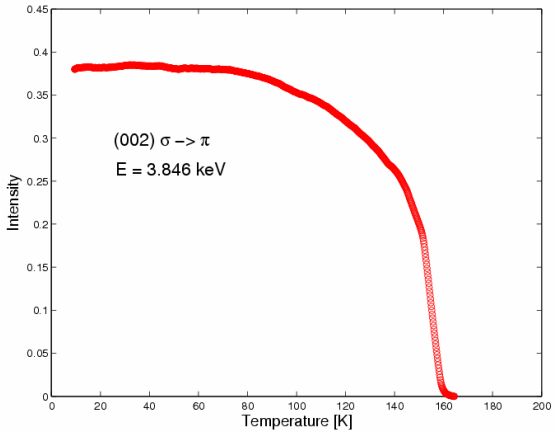

Fig 2

Fig 1 – Energy scan through the Np M_{IV} edge of the (002) reflection on the rotated σ→π channel, showing the large resonance below the ferromagnetic ordering temperature (data measured at 8 K on the $NpAs_{0.90}Se_{0.10}$ sample).

Fig 2 – Temperature dependence of the resonant scattering on the σ→π channel from the ferromagnetic component. The non-resonant scattering background due to polarisation leakage from the Au (111) analyser was subtracted.

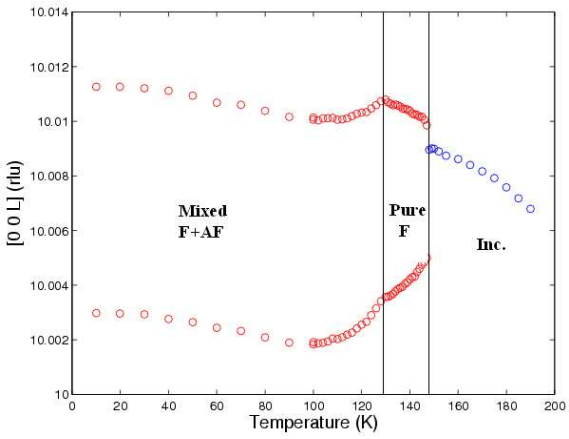

Fig 3

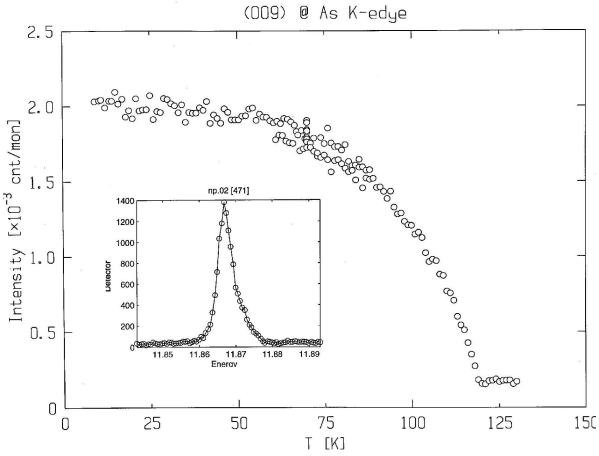

Fig 4

Fig 3 – Magnetostriction measured on the (0010) reflection with high energy photons (sample with 5% Se). The splitting of the charge peak induced by the onset of ferromagnetism is clearly seen.

Fig 4 – Temperature dependence and energy dependence (insert) of the (009) reflection measured at the As K edge on the σ→π channel (11.868 keV) (sample with 10% Se)

References:

1 - Bombardi A. et al., Phys. Rev. B 62 (2000), 14920-14927.

2 - Langridge S. et al., Phys Rev. B 49 (1994),12010-12021.

3 - Longfield M.J. et al. Phys Rev. B 64 (2001), 212407.